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REPORT OF THE SURVEYS OF THE MOUNTAIN-PINE BEETLE INFESTATION  
ON THE BEAVERHEAD NATIONAL FOREST  
1932

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In preceding reports concerning this project, it has been pointed out that the suppression of mountain-pine beetle epidemics requires not only a method of treatment but, in order to insure success, a fundamental knowledge of the application of control must be had as well. Much has been learned concerning the effects of control, the behavior of epidemics, and the insect causing them, but each year's accomplishments seem to but indicate the necessity for a greater number and more detailed studies of the problem. A study of the Beaverhead epidemic has been under way since 1929 to learn by means of an annual survey of all infested areas the annual losses, rates of increase, spread, sources of infestation and flight habits of the insects themselves. These studies are to be continued as long as the outbreak persists. In 1931 a study of the duration of the period of attack was instituted and continued on a more comprehensive scale in 1932. The ecology of a lodgepole pine stand following a mountain-pine beetle epidemic was also instituted in 1932.

Prior to 1928 the surveys of the Beaverhead infestation were conducted for the purpose of furnishing an estimate of the number and location of infested trees in order to properly plan the control measures which were instituted in 1926 and conducted for three years. Invasion of the control areas in 1928 by a tremendous number of insects caused so many trees to be attacked that further control work became uneconomical and the project discontinued. The data from these early surveys, though secured for a different purpose and complicated by control work, have been

of value in completing the information secured under the present study.

#### PRESENT STATUS OF THE PROJECT

Since instituting this survey, the project has been enlarged until in 1930 it embraced the entire original boundary of the Beaverhead National Forest. In 1931 data giving the status of mountain-pine beetle activity on the forks of Blacktail Creek and in Sheep Canyon were added due to their important bearing on the flight habits of the insect. Two other studies concerning the habits of attack of the mountain-pine beetle were also added in 1931. In 1932 these were continued on a more comprehensive scale and augmented by a study of the ecology of a lodgepole pine stand following a mountain-pine beetle epidemic.

Data giving the status of the epidemic on the Beaverhead Forest for 1932 indicate the number of trees attacked each year is still increasing. The following tabulation should give a clearer conception of the status of the infestation for each year.

#### INCREASE IN MOUNTAIN-PINE BEETLE INFESTATION BEAVERHEAD NATIONAL FOREST

Number of attacked trees in	1927	1928	1929	1930	1931	1932
	67,691(1)	321,272	2,098,873	3,859,276	12,238,732(2)	16,305,582(2)
Increase	-	253,581	1,777,601	1,760,403	8,379,456	4,066,850

(1) Estimate considered to have been too conservative.

(2) Estimates not corrected for effect of differences in date of survey on total infestation.

The figures given for 1927 are for the original unit acreage while those for succeeding years give the larger figures pertaining to the increased acreages. The revision of the 1927 estimate of attacks was not repeated in this report due to the belief that it would create an estimate



of uncertain value. However, the distribution of the infestation was more even in subsequent years and the revised estimates for them probably closely approach actual figures. It must be emphasized that leaving the 1927 estimate untouched and revising the one for 1928 gives an inflated value for the increase from 1927 to 1928.

A more detailed estimate of the attacked trees on each unit is given in Tables I and II.

TABLE I  
SUMMARY SHEET - BEAVERHEAD FOREST SURVEY - 1932  
COMPARISON OF THE INFESTATION FROM 1927 TO 1932 CAUSED BY THE MOUNTAIN-PINE BEETLE  
IN LODGEPOLE PINE

Unit	1927 Survey	Trees : Revised	Subsequent surveys - Attacked trees	1931	1932
	Acreage : treated	per acre: acreage	1928 : 1929 : 1930 : 1931		
Pintler	21,760	11,527 : .530	61,600 : 30,815 : 274,834 : 410,403	487,943	412,696
Missigbrod	20,480	12,479 : .610	56,300 : 62,940 : 262,402 : 508,483	908,994	1,129,368
Battlefield	37,120	3,454 : .093	102,400 : 43,816 : 467,636 : 1,006,586	3,114,270	1,924,487
West Side	33,280	- : -	76,500 : 29,897 : 210,521 : 457,655	1,543,978	1,459,305
Jackson	28,160	2,908 : .103	75,800 : 37,519 : 193,114 : 504,449	1,102,561	1,723,391
Bloody Dick	61,440	- : -	108,160 : 29,491 : 167,107 : 245,724	1,291,642	2,713,275
Horse Prairie	24,320	- : -	57,000 : 11,673 : 150,765 : 34,200	140,352	91,611
Battlesnake	48,000	- : -	68,400 : 3,694 : 14,706 : 7,990	108,565	498,383
Grasshopper	41,600	- : -	42,500 : 552 : 3,273 : 11,900	88,853	574,034
Warm Springs	51,200	- : -	54,500 : 20,165 : 86,819 : 113,277	1,111,319	1,736,060
East Side	49,280	21,110 : .428	86,200 : 35,208 : 210,136 : 415,172	1,509,164	653,794
Upper Wise	144,000	- : -	142,800 : 9,425 : 16,850 : 24,463	405,350	1,156,881
Lower Wise	61,440	3,567 : .058	59,000 : 6,077 : 25,960 : 65,556	230,600	878,150
Melrose	-	- : -	132,700 : - : - : 10,368	132,965	1,155,754
Lima	-	- : -	218,000 : - : 14,750 : 12,950	62,086	198,483
Totals	622,080	55,045 : .088	1,341,860 : 321,372 : 2,084,123 : 3,835,958	12,238,732	16,305,582

TABLE II  
COMPARISON OF ATTACKED TREES PER ACRE AND PER CENT OF  
INCREASE EACH YEAR FOR PERIOD 1927 TO 1932 - BEAVERHEAD FOREST SURVEY  
MOUNTAIN-PINE BEETLE IN LODGEPOLE PINE - 1932

Unit	1927		1928		1929		1930		1931		1932	
	Att.	%change	Att.	%change	Attacked	% change	Attacked	% change	Attacked	% change	Attacked	% change
	trees:	over	trees:	over	trees	over	trees	over	trees	over	trees	over
	per	prev.	per	prev.	per	previous	per	previous	per	previous	per	previous
	acre	year	acre	year	acre	year	acre	year	acre	year	acre	year
Pintlar	.530	-	.500	-6	4.462	792	7.150	60	7.921	11	6.699	-15
Mussiebrod	.610	-	1.118	83	4.661	317	9.033	93	16.146	79	20.060	24
Battlefield	.093	-	.428	360	4.567	967	9.830	115	30.413	209	18.794	-38
West Side	-	-	.391	-	2.752	604	5.982	117	20.183	237	19.124	-5
Jackson	.103	-	.495	380	2.548	415	6.655	161	14.546	119	22.735	56
Bloody Dick	-	-	.273	-	1.545	467	2.271	47	11.942	426	25.086	110
Horse Prairie	-	-	.205	-	2.644	1192	.600	-77	2.462	310	1.607	-35
Rattlesnake	-	-	.054	-	.216	298	.117	-46	1.587	1259	7.286	359
Grasshopper	-	-	.013	-	.077	493	.280	264	2.091	647	13.507	546
Warm Springs	-	-	.370	-	1.593	331	2.078	30	20.391	881	31.854	56
East Side	.428	-	.408	-5	2.438	497	4.816	98	17.508	263	7.508	-57
Upper Wise River	-	-	.066	-	.118	79	.171	45	2.838	1557	10.986	287
Lower Wise River	.058	-	.013	-78	.440	327	1.111	153	3.906	252	14.884	281
Melrose	-	-	-	-	-	-	.078	-	1.002	1182	8.710	769
Lima	-	-	-	-	.068	-	.059	-12	.290	379	.906	220
Averages	.088	-	.321	265	1.724	437	2.876	67	9.121	217	12.151	33.2

Inspection of Tables I and II indicates that the units of the Beaverhead Forest which have been subjected to heavy mountain-pine beetle attacks for the longest period of time are now with one exception showing a decline in the amount of infestation. Those showing a decline are the Pintlar, Battlefield, West Side and East Side units. The exception is the Mussigbrod unit which continued to show a gain in 1932. There is every indication that over this group of units as a whole the epidemic will continue to subside due to scarcity of acceptable host material. The units along the eastern edge of the forest will probably show increases for three or four years and then they too will show decreases due to lack of host material.

Tables I and II have been constructed without attempting to make the corrections necessary due to the survey being conducted before attacks are over for the season. From a study begun in 1931 and continued in 1932, it was determined that the mountain-pine beetle continues to attack trees even into late October in some seasons. Surveys begun prior to that time should be corrected to make up for this deficiency. The method used is fully discussed in another part of this report. At present no attempt will be made to correct data prior to 1931 as it is felt that data for at least three years are needed before a reasonably accurate correction factor can be evolved that would apply to any year. In Table III is shown corrected data for 1931 and 1932.



TABLE III  
ESTIMATES OF THE INFESTATION PRESENT ON EACH UNIT OF THE BEAVERHEAD NATIONAL FOREST PRIOR AND SUBSEQUENT  
TO CORRECTING THE ORIGINAL SURVEY DATA WITH A FACTOR OBTAINED FROM THE REPEATED EXAMINATION  
OF STRIPS IN 1931 AND 1932 - MOUNTAIN-PINE BEETLE IN LODGEPOLE PINE

Unit	Trees attacked in									
	1931					1932				
	Before correction		After correction		factor appld.	Before correction		After correction	factor appld.	% change
	Total	No. per acre	Total	No. per acre		Total	No. per acre	Total		
Pintlar	437,943	7.9	762,485	12.4		412,696	6.7	667,732	10.8	-12
Mussigbrod	908,994	16.1	1,336,675	23.7		1,129,368	20.1	1,424,904	25.3	7
Battlefield	3,114,270	30.4	4,445,696	43.4		1,924,487	18.8	2,471,203	24.1	-44
West Side	1,543,978	20.2	2,031,534	26.6		1,459,305	19.1	1,468,693	19.2	-28
Jackson	1,102,561	14.5	1,404,498	18.5		1,723,301	22.7	1,730,767	22.8	23
Bloody Dick	1,291,642	11.9	1,551,339	14.3		2,713,275	25.1	2,796,036	25.9	80
Horse Prairie	140,352	2.5	167,124	2.9		91,611	1.6	93,525	1.6	-44
Battlesnake	108,565	1.6	117,990	1.7		498,383	7.3	513,334	7.5	335
Grasshopper	88,853	2.1	91,587	2.2		574,034	13.5	574,034	13.5	527
Warm Springs	1,111,319	20.4	1,135,856	20.8		1,736,060	31.9	1,736,678	31.9	53
East Side	1,509,164	17.5	1,519,783	17.6		653,794	7.5	660,867	7.7	-57
Upper Wise River	405,350	2.8	408,694	2.9		1,156,881	11.0	1,166,162	11.6	185
Lower Wise River	230,690	3.9	231,068	3.9		878,150	14.9	893,323	15.1	287
Melrose	132,965	1.0	134,847	1.0		1,155,754	8.7	1,182,491	8.9	777
Lima	62,086	.3	63,344	.3		198,483	.9	206,422	.9	226
Averages	12,238,732	9.1	15,402,520	12.3		16,305,582	12.2	17,586,171	13.1	14.2
						1931 data:	12,238,732		15,402,520	
						Increase of 1932 over 1931:	4,066,852		2,183,651	
Per cent						"	33.2			14.2

The effect of the correction factor on the total number of attacks for each unit is quite striking on many of the areas, those surveyed earliest in the season showing a marked increase over the original figures.

The preceding tables indicate that the outbreak on the Beaverhead Forest had reached its peak on the northwestern units in 1931. Due chiefly to the decreases in attacks on those units the following year the total infestation over the entire forest increased but very slightly in 1932. The chief source of increase in the outbreak is undoubtedly the epidemic already present on the forest. Both the Bitterroot and Idaho epidemics may account for some of the increase in 1932, but in the main they probably contributed little to general infestation except on the Bloody Dick and Lima units. Units showing striking increases in infestation in 1932 probably owe much of it to the interchange of beetles from adjacent or nearby units rather than to invasions from distant sources. To show the effect of the epidemic on the forest from 1927 to 1932, Table IV has been prepared, giving the total number of trees killed per acre on different units during that period. Table IV also indicates the increases due to the use of a correction factor on data for 1931 and 1932.

TABLE IV  
TOTAL NUMBER OF TREES KILLED PER ACRE ON EACH UNIT  
BY THE MOUNTAIN -PINE BEETLE - PERIOD 1927-1932  
BEAVERHEAD NATIONAL FOREST

Unit	Trees killed per acre 1927-1932	
	From original	Including corrected data
	survey data	for 1931-1932
Pintlar	27.5	35.9
Mussigbrod	52.0	64.5
Battlefield	59.3	82.3
West Side	45.6	54.9
Jackson	47.1	51.2
Bloody Dick	41.2	44.3
Horse Prairie	7.8	8.0
Rattlesnake	9.3	9.6
Grasshopper	14.9	16.0
Warm Springs	56.3	56.8
East Side	33.3	33.4
Upper Wise River	14.5	15.9
Lower Wise River	17.9	19.6
Melrose	9.8	10.0
Lima	1.3	1.4
Average for forest	25.83	30.4

The preceding table gives an indication of the losses per acre but is deficient in its failure to show how many trees susceptible to mountain-pine beetle attacks were present per acre on the unit prior to the epidemic. Insect losses per acre have been heaviest on the Battlefield unit which contained an almost pure lodgepole pine stand and very few open areas to reduce the stand per acre average. Other units showing fewer killed trees per acre may have lost just as large a proportion of the lodgepole stand but unsusceptible species and many untimbered areas reduce the average stand per acre materially.

To secure some index of the original stand on an area, the per cent killed, the diameter classes killed and remaining and the general effect on the stand caused by a mountain-pine beetle epidemic, strips were run on some of the units of the Beaverhead Forest in 1932. This study is presented under the following heading.

DATA FROM THE REPEATED EXAMINATION OF THREE  
SAMPLE STRIPS DURING 1932

In 1931 two strips were examined at intervals during the summer to secure an index of the proportion of the final number of attacks which are present at certain times during the season. To make the data more representative of general conditions over the forest, one strip was located on the heavily infested Battlefield unit where infestation had been present for about five years and the second on the lightly infested Lower Wise River unit where the epidemic had been causing serious losses for only a year or two. The data from these two units served the original purpose, but suggested additional problems calling for a more comprehensive study. Accordingly, an additional strip was added in 1932 near the Elkhorn Ranger Station on the Grasshopper unit and the Lower Wise River strip was altered.

The method employed in making the 1932 examinations was to establish a strip one chain wide and  $4\frac{1}{2}$  or 5 miles long that was representative of stand conditions. The strips were run on section lines and their boundaries designated by paint marks on the trees at breast height. The status of attacks, diameters, and tree species in the stand were secured by examining tenth-acre sample plots at ten chain intervals and applying the data from them to as much of the intervening strip as they were representative of. Such designation was made possible by detailed timber type notes. From these data the status of all trees on the strip was obtained up to the 1932 season. Possibly greater accuracy would have been secured by full data for all trees on the strip, but the time required would have been prohibitive and it is believed sufficient accuracy for the purpose of the study was secured by the tenth-acre plot method adopted. When the examinations were made  
/in 1932, newly attacked trees were blazed and marked with a number corres-



pending to the number of the examination. In recording the data all new attacks on the strip were entered according to diameter, species, and class of injury, for each ten chain interval. Five divisions were made under class of injury caused by the mountain-pine beetle outbreak, which included: (1) pitched out, (2) green sided, (3) Dm. killed and (4) Dm. and Ips killed. The fifth class included the trees killed by Ips sp. It was found that up to the present time trees included in classes 4 and 5 only total about 2 per cent of the total injury and the amount is so small and unimportant that they have been included under class 3 to avoid unnecessary tabulation. Attacks by Ips sp. are apparently most numerous prior to July 15 and confined chiefly to areas where the infestation has not only been present the longest time but has resulted in heavy losses such as have occurred on the Battlefield unit.

The rate of attack on the three areas also showed a wide variation. Table V and Chart I show these differences. Data for the succeeding table were secured from Chart I on which points were plotted showing the per cent of the total number of attacks on succeeding dates and curves were then fitted to these points.

TABLE V  
TABLE SHOWING THE PER CENT OF THE TOTAL ATTACKS OF THE  
MOUNTAIN-PINE BEETLE AS OCCURRING ON DIFFERENT DATES OF 1932.  
DATA TAKEN FROM THREE PERMANENT STRIPS

Date	7/4	7/11	7/21	7/31	8/10	8/20	8/30	9/9	9/19	9/29	10/9	10/19	10/27
Per cent of total attack	:	:	:	:	:	:	:	:	:	:	:	:	:
Battlefield	Began: 4.5	: 13.5	: 30	: 66	: 86	: 93	: 96	: 97	: 99	: 99.5	: 100	: 100	
Wise River	Began: 2.0	: 7.5	: 19.5	: 40	: 68	: 81.5	: 86	: 88	: 90	: 92.5	: 97	: 100	
Elkhorn	Began: .2	: .3	: 4.5	: 22	: 83	: 92	: 95	: 96	: 97	: 98	: 99.5	: 100	
Average	Began: 2.2	: 7.1	: 18.0	: 42.7	: 79	: 88.8	: 92.3	: 93.7	: 95.3	: 96.7	: 98.8	: 100	

Not only was the variation great in 1932 between strips but also between averages of the strips for both 1931 and 1932. A greater volume of attack had occurred by August 7 in 1931 than on the same date in 1932, due probably to the later spring of 1932 and its retarding of both development and time of emergence of the mountain-pine beetle. These seasonal discrepancies apparently were overcome by August 20 only to develop again and result in a greater proportion of late attacks being recorded in 1932 than in 1931. These changes are indicated in Table VI.

TABLE VI  
AVERAGE PER CENT OF TOTAL NUMBER OF ATTACKS FOR CERTAIN DATES  
IN 1931 AND 1932 - MOUNTAIN-PINE BEETLE IN LODGEPOLE PINE  
BEAVERHEAD NATIONAL FOREST

Average % of:	:	:	:	:	:	:	:	:	:	:										
attacks on	:	8/7	:	8/10	:	8/15	:	8/20	:	8/25	:	9/1	:	9/15	:	9/30	:	10/5	:	10/30
1932 data	:	33	:	42.7	:	66	:	79	:	85	:	89.5	:	93	:	94	:	96	:	100
1931 data	:	60	:	65	:	72.5	:	79	:	84	:	90	:	96	:	99	:	99	:	100

The correction factor applied to survey date for the 1932 season is based on the average per cent of the total number of attacks found on the three check strips at various dates. Obviously, the first strips run during the season require the greatest correction and succeeding ones a lesser amount. Table III shows the effect of these corrections on the estimates of attacked trees on each unit. Only three units were greatly affected in 1932, as most of the survey of them was conducted in August; the majority of the forest being covered in late September and October. In 1931 most of the Beaverhead survey was conducted in August and September and the data consequently required a greater correction than was necessary for the 1932 data.

A comparison of the data before applying the correction factor shows a gain in attacked trees for 1932 over 1931 of about four million trees or

approximately 33 per cent. Applying the correction factor to the data for both years reduces the 1932 gain to slightly over two million trees or a little in excess of 14 per cent. By either method of comparison the gain in attacked trees in 1932 is the smallest since 1930 and seems to indicate that the infestation will not show as heavy losses in the future. The units on the eastern part of the forest will probably show tremendous gains but these should be more than offset by sharp declines on the northern and western parts of the Beaverhead.

#### THE BATTLEFIELD CHECK STRIP

It may be well to consider the data from each of the three check strips separately. On the Battlefield check strip the infestation has been present for the longest period and naturally shows the heaviest losses. There is also a larger per cent of the trees showing damaged or one-sided attacks on this strip. In Table VII the data from the Battlefield strip is shown in condensed form. The undamaged stand remaining is only 3.2 inches in average diameter, the trees killed have an average diameter of 8.5 inches, the damaged trees (green-sided and pitched out) about 7.2 inches. On the basis of the number of trees 1 inch or over in diameter killed up to November, 1932, the loss is light being only about 14.0 per cent, and 77.1 per cent of the stand remains as undamaged trees. The per cent of loss just given, however, does not have the significance it deserves as the trees killed average more than  $2\frac{1}{2}$  times the diameter of the lodgepole which have not been damaged. It is felt that the data compared on the basis of basal areas gives a better indication of the seriousness of the losses. Compared in that manner we find 48.0 per cent of the original stand killed and another 9.1 per cent damaged up to the present time, leaving 42.9 per cent of the basal area of lodgepole pine undamaged. Species other than lodge-

pole pine composed only 2.8 per cent of the number or 3.4 per cent of the basal area of the original stand. The per cent these other species are of the total has risen and will continue to rise as the destruction of the lodgepole pine increases. Their basal area has already increased from 3.4 to 7.5 per cent of the total undamaged stand, which indicates how timber types may be influenced by a bark beetle epidemic. In spite of this increase in the proportion of other species on the area, they still comprise such a small part of the undamaged timber as to influence the composition of the future stand but very little.



TABLE VII  
STATUS OF THE STAND ON THE BATTLEFIELD CHECK STRIP - MOUNTAIN-PINE BEETLE IN LODGEPOLE PINE  
BEAVERHEAD NATIONAL FOREST - 1932  
Based on 36.0 acres of strip of which 35.1 is timbered

Status of stand to 1931														
													% of	% of area
													orig-	original
													inal	basal
													stand	area
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Table VIII is shown to present, possibly a little more clearly, the conditions resulting from the presence of an infestation on an area for a number of years. In this table the trees in each diameter class are considered as a unit and their status shown in per cent of the total number of trees in that class. Inspection of the table shows there is a rapid decrease in the per cent of unattacked trees with increase in diameter indicating the smaller diameter trees are not favorable hosts of the mountain-pine beetle.

The per cent of trees killed rises with increase in diameter. Up to the present time all lodgepole pine on this strip above 15 inches in diameter have been killed and all above 11 inches damaged or killed. No unattacked lodgepole pine remain which are more than 11 inches in diameter and only slightly over 11 per cent are left of those in the range from 9 to 11 inches. In this same diameter range we find lodgepole pine indicating considerable resistance to attack judging from the more than 10 per cent that are green sided. Many green-sided trees are classes as resistant because they have been able to resist attack on all but one side of the tree. An indication of even greater resistance is indicated by the trees which have pitched out the bark beetle attacks. The greatest per cent of pitched-out attacks occurs in the 7 to 9 inch class, the next highest in those 5 to 7 inches in diameter. The per cent of green sided or pitched-out trees are negligible for those below 5 inches in diameter not because the trees are less resistant, but apparently due to their comparative immunity to attack up to the present time.

The residual stand of unattacked trees per acre on the Battlefield check strip up to the present time is as follows: lodgepole pine from 1 to 5 inches in diameter, 807 trees per acre; from 5 to 11 inches in diameter,

122 trees per acre; of species of all diameter other than lodgepole pine, 34 per acre, making a total stand of 963 trees per average acre. Diminishing direct losses from bark beetles will probably continue for a few more years and indirect losses from windthrow, windbreak, snowbreak and falling insect-killed trees for many more years, but all of them are not expected to greatly reduce the present stand. If fire can be kept out, the future stand on the northwestern units of the Beaverhead National Forest is believed to be fairly well represented in the trees now remaining on the Battlefield strip.

TABLE VIII  
CONDITION OF TREES IN EACH INCH CLASS THE FIGURES REPRESENT  
THE PER CENT OF TREES IN EACH CONDITION FOR THAT INCH  
CLASS ON THE BATTLEFIELD CHECK STRIP - BEAVERHEAD  
NATIONAL FOREST - DATA TO NOVEMBER, 1932

DBH classes	2	4	6	8	10	12	14	16	18	20	22
Unattacked DF	:	:	:	:	:	:	:	:	:	:	:
Other species	3.22:	2.57:	1.84:	2.12:	2.55:	1.60:	2.57:	-	-	100.0:	100.0:
Unattacked LP	96.75:	92.00:	49.72:	20.04:	11.18:	-	-	-	-	-	-
Killed LP	.01:	4.35:	23.66:	37.27:	73.94:	94.56:	94.58:	100.0:	100.0:	-	-
Green sided LP	.005:	.32:	2.79:	12.73:	10.51:	2.72:	1.71:	-	-	-	-
Pitched out	.015:	.76:	21.90:	27.84:	1.82:	1.12:	1.14:	-	-	-	-

#### THE WISE RIVER STRIP

Data from the Wise River check strip showed the same general tendency as the data from the previously discussed Battlefield strip and the Elkhorn strip. The trees killed on the Wise River strip were of the larger diameter classes and averaged 10.0 inches, those damaged but still living were slightly smaller with an average diameter of 8.5 inches. The changes on this strip caused by the bark beetles have been presented in two ways in Table IX, showing first the number of trees killed and damaged and then their basal area, following the same plan as in Table VII. The remaining stand is also shown

in the tabulation. The number of trees killed in proportion to the total number on the strip is quite small being only 6.9 per cent of the original lodgepole stand above one inch in diameter and even less on the basis of the entire stand which contains a fairly large proportion of Douglas fir and other species. Losses do not appear at their full value, however, when one considers them on the basis of the number of trees killed because the destruction has been in the larger diameter classes while the average tree on the strip is quite small. Just as for the Battlefield check strip data, the basal area estimate gives more clearly the significance of the losses, because each tree is given a weighted value which increases as diameter increases. On the latter basis, losses (killed and damaged trees) already amount to 33.7 per cent of the original lodgepole stand. Table IX shows these losses and also other data concerning the strip. A comparison of the per cent of losses indicates that computed by basal area they are over four times, 33.7 per cent, the amount computed according to the number of trees, which is 8.1 per cent.

Inspection of Table IX indicates there are many living lodgepole pine above 6 inches in diameter still on the strip. They are quite susceptible to attack while those below that diameter show very nominal losses judging from the experience on the Battlefield strip up to the present time.

The present epidemic has only been serious on the Wise River area for two years, but in that time it has destroyed about one-third of the basal area of the lodgepole pine stand. Destruction of the remaining lodgepole pine of susceptible size should occur at a very rapid rate due to the tremendous volume of infestation already present on the area and



TABLE IX

STATUS OF THE STAND ON THE WISE RIVER CHECK STRIP - MOUNTAIN-PINE BEETLE IN LODGEPOLE PINE  
BEAVERHEAD NATIONAL FOREST - 1932

Based on 40.0 acres of strip of which 33.0 acres was timbered with conifers, .5 acre with aspen and 6.5 acres open.

Status of stand to 1931															: % of : orig- : inal : stand	: Sq. ft. : of : basal : area	: % of or- : iginal : basal : area	: Aver- : age : DBH
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:				
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:				
DBH classes	: 2	: 4	: 6	: 8	: 10	: 12	: 14	: 16	: 18	: 20	: 22	: 24	: 26	Total				
DF	: 2,484	: 1,481	: 640	: 392	: 256	: 325	: 186	: 133	: 29	: 18	: -	: 9	: 9	5,962	: 21.2	: 1,377.24	: 31.8	: 5.1
Other species	: 348	: 545	: 352	: -	: -	: -	: -	: -	: -	: -	: -	: -	: -	1,245	: 4.4	: 124.26	: 2.9	: 4.0
Green LP	: 8,526	: 7,057	: 2,209	: 1,836	: 558	: 341	: 123	: 31	: 28	: -	: -	: -	: -	20,709	: 73.7	: 2,672.67	: 61.6	: 4.1
Killed LP	: -	: -	: 5	: 38	: 14	: 47	: 80	: -	: -	: -	: -	: -	: -	184	: .7	: 144.29	: 3.3	: 11.7
Green sided LP	: -	: -	: -	: -	: 12	: -	: -	: -	: -	: -	: -	: -	: -	12	: -	: 6.54	: .1	: 10.0
Pitched out LP	: -	: -	: -	: -	: 14	: -	: -	: -	: -	: -	: -	: -	: -	14	: -	: 11.00	: .3	: 12.0
Totals	: 11,358	: 9,083	: 3,206	: 2,266	: 840	: 727	: 389	: 164	: 57	: 18	: -	: 9	: 9	28,126	: 100.0	: 4,336.0	: 100.0	: 4.4

To 1932															: % of : orig- : inal : stand	: Sq. ft. : of : basal : area	: % of or- : iginal : basal : area	: Aver- : age : DBH
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:				
:	:	:	:	:	:	:	:	:	:	:	:	:	:	:				
DBH classes	: 2	: 4	: 6	: 8	: 10	: 12	: 14	: 16	: 18	: 20	: 22	: 24	: 26	Total				
DF	: 2,484	: 1,481	: 640	: 392	: 256	: 325	: 186	: 133	: 29	: 18	: -	: 9	: 9	5,962	: 21.2	: 1,377.24	: 31.8	: 5.1
Other species	: 348	: 545	: 352	: -	: -	: -	: -	: -	: -	: -	: -	: -	: -	1,245	: 4.4	: 124.26	: 2.9	: 4.0
Green LP	: 8,526	: 7,045	: 2,033	: 1,283	: 194	: 72	: 47	: 4	: 9	: -	: -	: -	: -	19,213	: 68.3	: 1,864.50	: 42.9	: 3.7
Killed LP	: -	: 10	: 126	: 484	: 339	: 295	: 155	: 26	: 19	: -	: -	: -	: -	1,454	: 5.2	: 855.55	: 19.7	: 10.0
Green sided LP	: -	: 1	: 16	: 31	: 24	: 4	: -	: -	: -	: -	: -	: -	: -	76	: .3	: 33.93	: .8	: 8.4
Pitched out LP	: -	: 1	: 39	: 76	: 27	: 31	: 1	: 1	: -	: -	: -	: -	: -	176	: .6	: 80.52	: 1.9	: 8.6
Totals	: 11,358	: 9,083	: 3,206	: 2,266	: 840	: 727	: 389	: 164	: 57	: 18	: -	: 9	: 9	28,126	: 100.0	: 4,336.0	: 100.0	: 4.4

LP comprised 74.4% of the number or 65.4% of the basal area of the original stand.

At end of 1931 killed LP were 88% of number or 5.09% of basal area of original LP stand.

	damaged	"	"	.13"	"	"	"	.62"	"	"	"	"	"	"	"	"	"	"
At end of 1932	killed	"	"	6.88"	"	"	"	29.69"	"	"	"	"	"	"	"	"	"	"
	damaged	"	"	1.21"	"	"	"	4.02"	"	"	"	"	"	"	"	"	"	"
	undamaged	"	"	91.91"	"	"	"	66.29"	"	"	"	"	"	"	"	"	"	"

to additional insects invading the Wise River area from nearby units to the west.

The Wise River area differs from the Battlefield area in possessing a comparatively large amount of species other than lodgepole pine. Before the present infestation began these comprised 34.7 per cent of the total basal area. Since the epidemic, that proportion has been raised to 44.6 per cent of the undamaged trees and it will continue to increase as long as losses in lodgepole pine continue. Ultimately these other species should make up over 50 per cent of the basal area of the stand. It will be interesting to determine what effect, if any, the presence of these other species will have on the ultimate losses in lodgepole pine.

Four examinations were made of the Wise River strip during the 1932 season, the first in June to secure the status of the stand, the second on August 6, and the third on September 21 and 22, and the fourth on October 17. Assuming the strip gave conditions representative of the area, 30 per cent of the total attack had occurred on August 6, 58 per cent by September 21 and 22, and 100 per cent by October 17.

The intensity of attack on individual trees changed as the season progressed. Up to <sup>the</sup> August 6, examination attacks were almost always successful but between August 6 and September 22 nearly 10 per cent of the trees were unsuccessfully attacked, this proportion rising to more than 52 per cent between September 22 and October 17. This increase in the number of unsuccessful attacks with advance in season seems to indicate that the number of insects attacking a tree in a given period of time decreased as the season advanced, making it possible for many trees to repel the attack or to at least limit successful attack to one side of the tree. The insects making these late attacks were probably parent adults which had already attacked a tree and constructed one egg gallery.

A condensed table showing the character of these attacks follows:

TABLE X  
CHANGE IN THE CHARACTER OF ATTACK WITH ADVANCE IN SEASON  
MOUNTAIN-PINE BEETLE IN LODGEPOLE PINE - BEAVERHEAD NATIONAL FOREST  
1932

Character of attack	Number of trees				Total	Per cent of total attack
	8/6	9/22	10/17			
Pitched out	2	32	128		162	10.9
Side of tree dead	-	51	13		64	4.3
Killed by Ips	2	-	-		2	.1
Killed by Dm.	442	780	30		1252	84.7
Totals	446	863	171		1480 (1)	100.0

(1) Discrepancies in total compared with Table IX due to attacks for two successive years on 16 trees.

The Elkhorn and Battlefield strips showed the same general tendency as depicted in Table IX as far as classes of attack in relation to date of examination are concerned.

#### THE ELKHORN STRIP

The Elkhorn check strip has suffered the least loss of any of the three check strips. The combined loss in killed and damaged trees is only 10 per cent of the original basal area on the strip. These losses have been chiefly in the trees of larger diameter. It has been a general observation that it is chiefly the largest diameter trees that are the first to be attacked when an epidemic of the mountain-pine beetle invades an area. This is confirmed by the following data from the three check strips examined during the 1932 season.

AVERAGE DBH OF THE TREES KILLED  
BY THE MOUNTAIN-PINE BEETLE

DBH of trees killed to	Strip			
	Battlefield	Wise River	Elkhorn	
1931	9.5	11.7	12.1	
1932	8.5	10.0	10.8	

The impression should not be gained that the beetles attack only the largest trees each succeeding year. Some small trees are also killed but the larger diameters always bear the brunt of the losses.

The data for the Elkhorn strip are presented in Table XI. This strip had approximately the same proportion of lodgepole pine in the stand composition as the Battlefield strip, but differed from it in the smaller diameter of the average tree of the original stand and in having a smaller proportion of the area timbered.

As the Wise River and Elkhorn strips were inaugurated at a time when the epidemic was just beginning to be serious, examination of them over a period of years should give some valuable data concerning the class of timber selected in successive years.

TABLE XI  
STATUS OF THE STAND ON THE ELKHORN CHECK STRIP - MOUNTAIN-PINE BEETLE IN LODGEPOLE PINE  
BEAVERHEAD NATIONAL FOREST - 1932  
Based on 36.0 acres of strip of which 28.1 acres are timbered

Status of stand to 1931															% of	Sq. ft.	% of orig-																					
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	orig-	of	iginal	Aver-																				
	:	:	:	:	:	:	:	:	:	:	:	:	:	:	inal	basal	basal	age																				
DBH classes	:	2	:	4	:	6	:	8	:	10	:	12	:	14	:	16	:	18	:	20	:	22	:	24	:	26	:	28	:	total	stand	area	area	DBH				
DF	:	23	:	6	:	-	:	-	:	11	:	-	:	-	:	-	:	-	:	-	:	-	:	4	:	-	:	4	:	48	:	.1	:	36.68	:	.86	:	8.1
Other species	:	297	:	123	:	11	:	6	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	437	:	1.1	:	21.47	:	.50	:	2.7
Green LP	:	19,217	:	10,504	:	4,160	:	2,016	:	685	:	541	:	213	:	151	:	19	:	7	:	-	:	-	:	8	:	-	:	37,521	:	98.7	:	4,167.34	:	97.43	:	3.8
Killed LP	:	-	:	-	:	10	:	-	:	6	:	17	:	-	:	19	:	-	:	-	:	-	:	-	:	-	:	-	:	52	:	.1	:	44.59	:	1.04	:	12.1
Green sided LP	:	-	:	-	:	-	:	-	:	-	:	9	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	9	:	-	:	7.07	:	.17	:	12.0
Pitched out LP	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-	:	-
Totals	:	19,537	:	10,633	:	4,181	:	2,022	:	702	:	567	:	213	:	170	:	19	:	7	:	-	:	4	:	8	:	4	:	38,067	:	100.0	:	4,277.15	:	100.0	:	3.8

To 1932																								
DF	:	23:	6:	-	:	-	:	11:	-	:	-	:	-	:	-	:	4:	-	4:	48:	.1:	36.68:	.86:	8.1
Other species	:	297:	123:	11:	6:	-	:	-	:	-	:	-	:	-	:	-	-	-	437:	1.1:	21.47:	.50:	2.7	
Green LP	:	19,217:	10,504:	4,115:	1,908:	595:	442:	121:	116:	-	:	-	:	-	:	-	-	37,018:	97.3:	3,791.20:	88.63:	3.7		
Killed LP	:	-	:	-	:	42:	88:	77:	106:	89:	53:	19:	7:	-	:	-	8:	-	489:	1.3:	387.81:	9.07:	11.8	
Green sided LP:	-	:	-	:	8:	6:	3:	11:	-	:	-	:	-	:	-	-	-	28:	.1:	13.94:	.33:	9.2		
Pitched out LP:	-	:	-	:	5:	14:	16:	8:	3:	1:	-	:	-	:	-	-	-	47:	.1:	26.05:	.61:	9.7		
Totals	:	19,537:	10,633:	4,181:	2,022:	702:	567:	213:	170:	19:	7:	-	:	4:	8:	4:	38,067:	100.0:	4,277.15:	100.00:	3.8			

LP comprised 98.5% of the number and 98.8% of the basal area of the original stand.

At end of 1931 killed LP were .13% of number or 1.06% of basal area of the original LP stand.

damaged "	"	.02"	"	"	"	.17"	"	"	"	"	"	"	"	"	"	"	"	"	"
At end of 1932 killed	"	"	1.30"	"	"	"	9.19"	"	"	"	"	"	"	"	"	"	"	"	"
damaged "	"	"	.20"	"	"	"	.95"	"	"	"	"	"	"	"	"	"	"	"	"
undamaged "	"	"	98.50"	"	"	"	89.83"	"	"	"	"	"	"	"	"	"	"	"	"

In addition to the three check strips, additional examinations were made on the Battlefield unit in June and on the Battlefield and Mussigbrod units in August to determine stand losses. On these areas the infestation has been present the greatest length of time and gives a better indication of the final status of the stand.

The June examinations were made on strips one chain wide, recording the status, species, and diameters of all trees down to one inch in diameter for each ten chains. This method was found to require a prohibitive amount of time and when the examinations were made in August the newly attacked, the dead trees, and the living trees by species were recorded for diameters of 3" and above by hundreth-acre plots every ten chains. It was felt that these plots would furnish sufficient data, where a large number of them were obtained, to indicate the status of the stand on the remainder of the strip on which only the living, newly attacked, and dead trees were recorded by ten chain intervals.

The table which follows gives the data secured from these examinations:

LOSSES CAUSED BY A MOUNTAIN-PINE BEETLE INFESTATION  
IN LODGEPOLE PINE - BEAVERHEAD N. Y., 1932

	: Data secured in June, 1932, :				: Data secured in August, 1932, :			
	: from 6.7 acres of strip				: from 226.2 acres of strip			
	: Green trees :				: Green trees :			
	: 1" DBH & over: Dead LP				: 3" DBH & over: Dead LP			
No. of trees:	(1)	:	(2)	:	(1)	:	(3)	:
per acre :	458.9	:	111.3	:	118.7	:	123.6	:
% of total :		:		:		:		:
No. of trees:	80.9	:	19.1	:	49.0	:	51.0	:
		:		:		:		:
Average DBH :	4.4	:	8.3	:	5.6	:	8.7	:

- (1) Includes other species than lodgepole pine
- (2) Does not include 1932 attacks
- (3) Includes 1932 attacks

Inspection of the preceding data shows the average diameter of the killed trees to be 8.3 and 8.7 inches and to correspond very closely to that of the trees on the check strip on the Battlefield area, which averaged about 8.5 inches. The average diameter of the trees remaining on the Battlefield check strip corresponds closely to the trees remaining on the areas examined for stand losses in June of 1932. The data secured in June and from the check strips included trees down to 1" in diameter while that secured in August did not include trees below 3" in diameter, which accounts in large measure for the remaining trees in the data obtained in August having the highest average diameter.

The per cent of the number of trees other than lodgepole pine on these areas is practically 4.0 per cent of the stand. The species included are Douglas fir, Engelmann spruce, alpine fir, whitebark or limber pine, aspen, and a very few yellow pine.

The time is not far distant when it will be possible to obtain data on the final direct losses caused by the mountain-pine beetle on areas in the Big Hole Basin. The figures given from the data secured in 1932 can only indicate losses up to the present time as the insects are still active on all areas of the Beaverhead Forest. However, as the infestation is in general decreasing on the areas from which these stand-loss data were obtained, it is felt the figures given will not be changed materially.

Inspection of the data on stand losses indicates quite clearly the definite selection of the larger diameter classes by the mountain-pine beetle. That these larger classes are not only more desirable but also more easily overcome is indicated by the complete destruction of the larger trees and the increasing resistance to attack exhibited by the smaller diameter trees. The number of trees killed that are less than five inches

in diameter has been but a very small per cent of the total. These statements apply only to the Battlefield unit on which the destruction has been greater than on either of the other two strips. Indications are strong, however, that the condition depicted by the Battlefield strip will be duplicated on the remainder of the forest within a few years.

On the basis of merchantability, and considering eleven inches as the minimum diameter limit of merchantable trees, we find practically 100 per cent of the merchantable lodgepole pine have been destroyed. The few green-sided trees remaining are not merchantable and the still smaller number that have pitched out former attacks still have the hazards of an active infestation to face for a few years.

#### STATUS OF THE INFESTATION ON EACH UNIT

The detailed discussion following, Tables I, II, III and IV, and Chart II should aid in a clearer understanding of conditions on each unit.

##### Pintlar Unit

Pintlar unit showed a decrease of 12 per cent in infestation in 1932. Two factors are believed to be chiefly responsible for this decrease. The heavy infestation which has been present on the area has reduced the stand to the point where there is a decided shortage of host material. This unit is also becoming yearly more remote from the active part of the Bitterroot infestation which undoubtedly contributed very heavily to the infestation in the past. The decrease on this unit should be a decided one in subsequent years.

##### Mussigbrod Unit

The Mussigbrod unit showed a 7 per cent gain in infestation in 1932 over 1931. Although still showing an increase in total infestation the



rate of gain was decidedly less than for the preceding year and indicates that the peak of the infestation has been reached. Some of the infestation on the Mussigbrod unit in 1932 may have been due to a heavy influx of beetles from the Battlefield unit and also to some extent from the Bitterroot infestation. A decrease in infestation should occur in the 1933 season since available host material is rapidly decreasing and highly resistant to attack. This unit has suffered the second heaviest loss of any unit on the forest up to 1932 with about 64.5 trees killed per acre as shown in Table IV.

#### Battlefield Unit

The decided decrease of 44 per cent on this unit in 1932 is a striking contrast to the gain of the previous year and indicates the peak of the loss on this unit was reached in 1931. In spite of this decrease the number of trees attacked on this unit in 1932 was the second highest of any unit and far in excess of the third highest, as may be seen from the corrected data in Table III.

In spite of the general decrease in infestation on the Pintlar, Mussigbrod and Battlefield units, losses to date on these three areas still amount to about 36 per cent of the total losses which have occurred on the forest. On the Battlefield unit alone the number of trees attacked to November, 1932, has amounted to over 21 per cent of the total trees killed to date.

The 1933 season should show a further decrease in the number of attacked trees due not only to the scarcity of host material but also to a probable decrease in the influx of beetles from the Bitterroot and Idaho sources.

#### West Side Unit

The decrease of 28 per cent in the number of attacked trees on this area in 1932 indicates that the peak of losses was reached on this unit in 1931. The number of trees attacked should continue to decrease but should invasions of beetles from Idaho and heavily infested units to the south occur, losses may be held to a fairly high level for a year or two on this unit.

#### Jackson Unit

This unit showed an increase of 23 per cent in number of attacked trees which is slightly in excess of the average for the forest during the 1932 season. However, unless invasions by beetles from Idaho sources or from the units to the south occur, it is believed the peak of the losses has been reached on this unit.

#### Bloody Dick Unit

The 80 per cent gain in number of attacked trees on this unit was exceeded by six other areas in 1932, but in gain in total number of trees attacked its approximate 1,250,000 was considerably in excess of that of any other unit. The per cent of increase on this unit is considerably below what could have occurred from insects already present on the area, but a decrease in infestation on the Horse Prairie unit adjoining on the south and very little gain on the Jackson unit on the north leads the writer to conclude that either invading insects from Idaho contributed to part of the increase or else many insects flew from the Horse Prairie unit to the Bloody Dick unit. Losses on this unit in 1933 should not equal those for 1932 unless a very heavy invasion occurs from Idaho.

#### Horse Prairie Unit

A decrease of 44 per cent in the number of attacked trees on this unit in 1932 is somewhat puzzling to the writer in view of the decided increases in the units adjoining on the north and south. The only explanations that the writer can offer are that invasions from Idaho into this unit were not heavy, that heavy migrations occurred from this unit, that only timber highly resistant to attack remains on the area, or that the strips run were not representative of conditions on the area. The writer does not feel justified in predicting the trend of the infestation on this area in the immediate future.

#### Lime Unit

The attacks in 1932 increased 226 per cent over 1931, an amount entirely possible from infestation already present on the area if the stand is continuous. However, the occurrence on this unit of the timber in scattered patches would, in the opinion of the writer, cause high mortality among insects searching for their host. For this reason the writer believes it is probable that some bark beetles invaded this area from outside sources and contributed to the increase.

#### Rattlesnake Unit

Losses on this unit showed a 335 per cent increase in 1932, a condition which will probably be duplicated for a number of years in spite of a considerable proportion of unsusceptible species and much open country. This increase is the maximum that might be expected from an infestation already present on an area. If insects from outside sources contributed to the increase they probably came from the more heavily infested units to the west.

#### Melrose Unit

This area showed the highest per cent (777) and the second highest total increase in infestation on the Beaverhead Forest in 1932. Even on the supposition that an abnormally large amount of parent adult emergence occurred in 1932, that the invasion of this area has been but a recent one and host material was abundant, the writer does not believe local infestation could have been responsible for all the increase on this area in 1932. Therefore, the writer feels amply justified in stating that invading insects contributed to the increase on this unit in 1932. The most likely source of invading insects was adjoining or nearby units to the west. Losses probably will continue to increase on this unit for a number of years.

#### Grasshopper Unit

The Grasshopper unit is similar to the Melrose unit in that the increase of 527 per cent in 1932 over the previous year is greater than could be expected from infestation already present on the area. The source of invading beetles was most likely in units to the west. Losses on this unit are decidedly on the upward trend and will probably continue to increase for a number of years.

#### Upper Wise River Unit

The infestation is well established on this unit and the 1932 increase will probably be duplicated for a number of years to come. Infestation already established on the area could have caused the 180 per cent increase noted on this unit. If any insects came into the area they were probably from the areas adjacent on the west.

#### Warm Springs Unit

Local infestation could have caused the increase of 53 per cent on this unit in 1932. Losses on this area should decrease in 1933.

#### East Side Unit

Apparently the peak of loss on this unit was reached in 1931 and succeeding years will witness a continuance of the downward trend begun in 1932. Infestation already present on the area not only could have accounted for the infestation present in 1932, but at the same time have contributed to the gain on adjoining areas to the south and west.

#### Lower Wise River Unit

The increase in number of attacked trees amounted to 287 per cent in 1932. Gains in number of attacked trees should continue on this unit for a number of years. Unless local infestation was responsible for all the increase, nearby units to the west and north were the most likely contributors to the gain.

#### GENERAL STATUS OF THE BEAVERHEAD INFESTATION

The estimated number of trees attacked in 1932 was about 17,500,000, or approximately 45 per cent of the total loss on the forest since 1927. In the 1931 report of this survey, the writer estimated the diameter of the average tree attacked to 1931 to have been about 9 inches. Studies made in 1932 indicate this 1931 figure should have been 9.5 inches. The same studies show the average diameter of trees attacked from 1927 to 1932 has been about 8.4 inches. For losses up to 1932 the figure of 50 board feet per tree as used in 1931 is believed to be too high. The average board foot contents of attacked trees up to 1932 are believed to average nearer

30 per tree, which would make the losses for about 39,250,000 trees over 1,175,000,000 board feet. About 75 per cent of the trees, or 45 per cent of the board foot volume, however, is in trees below 10 inches in diameter, leaving a loss of 25 per cent in total attacked trees, or 55 per cent of the board foot volume loss occurring in trees above 10 inches in diameter. Of the total loss, therefore, 650,000,000 board feet have occurred in trees over 10 inches in diameter. The estimate of lodgepole pine, whitebark pine, and limber pine submitted by the Forest Service is 1,270,659,000 board feet of merchantable timber for the Beaverhead Forest. It is assumed no timber was considered merchantable that was below 10 inches in diameter breast high. Comparing the loss up to the present with the estimate for trees over 10 inches shows 51 per cent of the merchantable timber has been killed to date. Continuation of the infestation on the northwestern units of the forest will not increase the total merchantable timber loss materially as the remaining timber is for the most part under 10 inches in diameter. On the more recently infested eastern units of the Beaverhead Forest many of the trees attacked are the larger ones and their destruction will materially raise the estimate of losses of merchantable timber.

#### MOUNTAIN-PINE BEETLE FLIGHT

One object of the annual survey of the Beaverhead National Forest is to gain some idea of the ability of the mountain-pine beetle to make long and sustained flights. An insect survey in 1930 revealed the presence of an active infestation of the mountain-pine beetle in the isolated lodgepole pine stands in the Sheep Canyon area and the three forks of Blacktail Creek. Indications were strong that beetles had flown into this area from points at least 25 miles to the west. Control work was instituted in 1931 on the aforementioned areas. A survey in the fall of 1931 showed such a tremendous

increase in infestation as to leave no doubt that outside sources were responsible for the major portion of the 1931 infestation found on those areas. To aid in visualizing the conditions found on the area, Table XII has been prepared giving the data secured up to the 1932 season.

TABLE XII  
STATUS OF THE MOUNTAIN-PINE BEETLE INFESTATION ON  
BLACKTAIL CREEK DRAINAGE FROM 1930 TO 1932

Area	No. of trees: treated in 1931*	Probable No. of trees left in 1931*	Trees attacked: in 1931	Trees attacked: in 1932 (4)
Sheep Canyon	3,045	500	23,183	151,000
W. Fk. Blacktail	971	250 (1)	3,200	
Mid. Fk. "	196	-	350	11,085(5)
East Fk. "	641	200 (2)	2,050	
Clover, Wolverine,				
West & Middle Creeks	-	-	1,375(3)	8,232(6)
Total	4,853	950	30,158	170,317

\* 1930 attack.

(1) Includes one group of 45 trees.

(2) Includes large untreated area.

(3) Included in West and East Forks in 1930.

(4) Correction factor applied for date of survey using Beaverhead check strips as basis for correction.

(5) West Fork and Middle Fork data.

(6) East Fork data included.

The preceding data show the extremely large increase in the infestation on the Sheep Canyon drainage in 1932. Amounting as it does to about 552 per cent, it indicates that again outside sources contributed materially to the infestation already present on the area. The 1932 increases on the other parts of the Blacktail Drainage could have been caused by infestation already established on those areas.

Plates I, II, III, and IV give some idea of the Blacktail Drainage and of other areas surveyed.

#### DATA CONCERNING ADMINISTRATION OF THE SURVEY

The area of the strips run on the Beaverhead National Forest in 1932 amounted to .45 of one per cent of the total area of the forest, as compared with .87 for 1931 and .69 in 1930. It was believed the smaller amount of strip run in 1932 would, under the condition of general infestation existing over the forest, give sufficiently accurate data for the purpose of the survey.

The average miles of strip per man-day again decreased in 1932. The increase in the amount of data which are obtained with the increasing infestation tends to reduce the miles of strip which a man can cover in a day.



TABLE XIII  
SUMMARY AND ANALYSIS OF RESULTS AND COSTS OF  
BEAVERHEAD NATIONAL FOREST SURVEY - 1932

Items	Man-days on project					Total
	Unit strip(1)	Check strip <sup>2</sup>	Stand loss	Office	Inef- fective	
Man-days spent on survey	95	31½	15½	52	32½	226½
Miles of sample strip						804.3
Miles of strip per man-day	8.11					3.55
No. of sample strip acres	6,435					
" " " " per man-day	62.2					28.4
Acres covered by survey						1,415,340
" " per man day	13,675					6,429
<u>Total cost of survey</u>						
Labor						\$1216.76
Transportation						138.16
Subsistence						286.00
Equipment						2.30
Telephone & telegraph						3.01
						<u>\$1646.23</u>
<u>Cost of survey distributed</u>						
Cost per man-day						7.27
Cost per mile of strip						2.05
" " sample acre						.256
" " acre of region surveyed						.0012
Per cent of total area actually covered by survey						.45
Total meals in camp						380.
Total cost of meals in camp						\$140.00
Cost per meal						.40

(1) Consists only of the strip run on the units to determine the amount of infestation

<sup>2</sup> Includes the three strips repeatedly examined to determine the amount of attack for different periods.

#### SUMMARY

The outstanding findings of the 1932 survey were as follows:

- (1) A continued increase in the infestation from 15,402,520 trees in 1931 to 17,586,171 in 1932.
- (2) Strong indications that the infestation has passed its peak on the northwestern units of the forest.
- (3) Indications that if flight of insects from Idaho and the Bitterroot into the Beaverhead Forest is occurring it is augmenting the infestation already established there but very little.
- (4) Continued evidence of flight of the mountain-pine beetle over untimbered country to infest an isolated area of lodgepole pine at least 20 miles from the nearest infestation.
- (5) Evidence that the period of attack was a long one in 1932 and that it varied somewhat from the 1931 season.
- (6) Indications that few, if any, lodgepole pine will remain after the outbreak which are larger than 10 inches in diameter.
- (7) Indications that at least 60 per cent of the basal area of all lodgepole pine over 1 inch in diameter breast high, will be destroyed before insect activity ceases on an area.

Respectfully submitted,

*Archie L. Gibson*

A. L. Gibson

Assistant Entomologist

Chart I

ESTIMATE OF THE PER CENT OF THE FINAL NUMBER OF  
MOUNTAIN-PINE BEETLE ATTACKED TREES PRESENT ON THE BEAVERHEAD NATIONAL  
FOREST ON VARIOUS DATES AS OBTAINED FROM THE REPEATED EXAMINATION OF  
THREE SAMPLE STRIPS  
1932

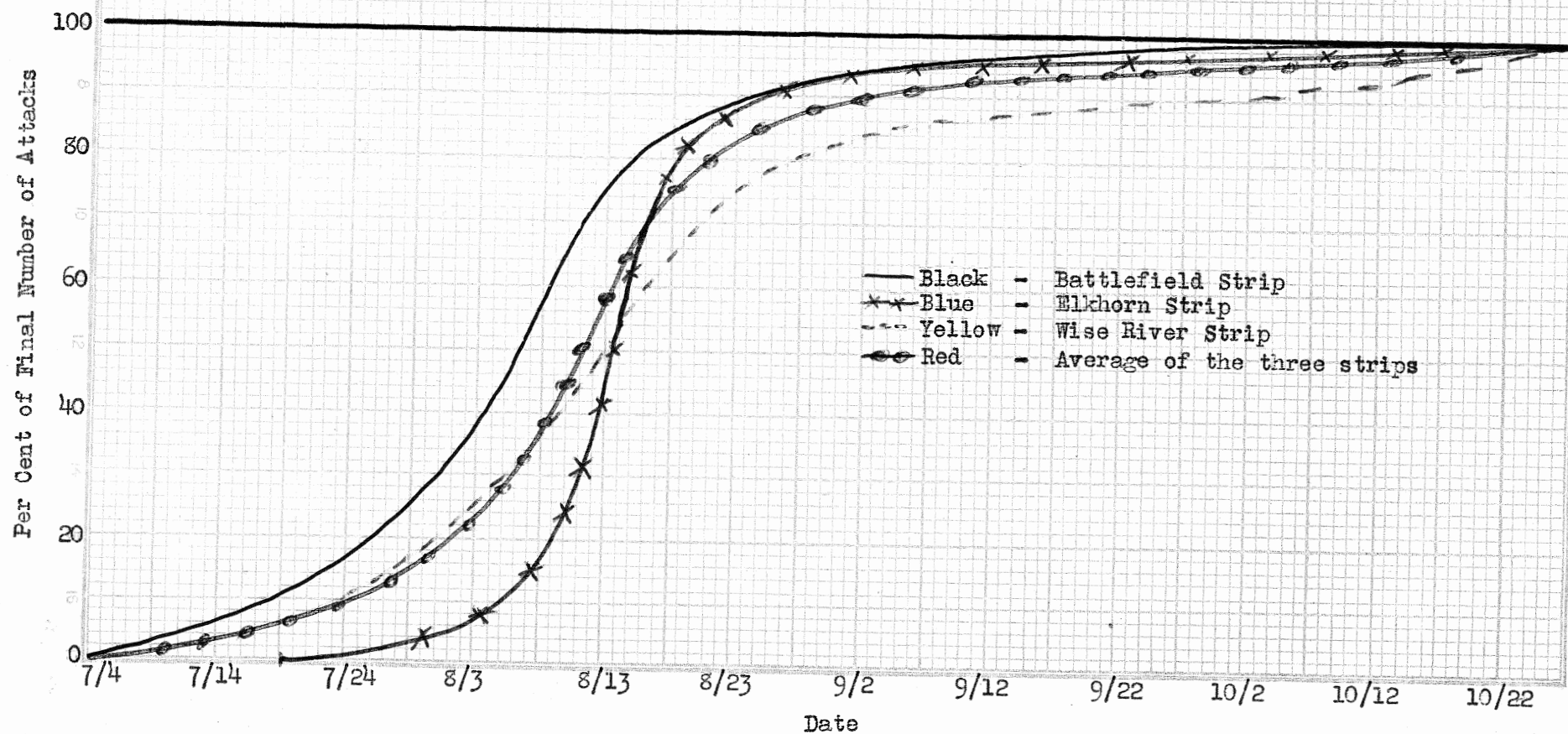
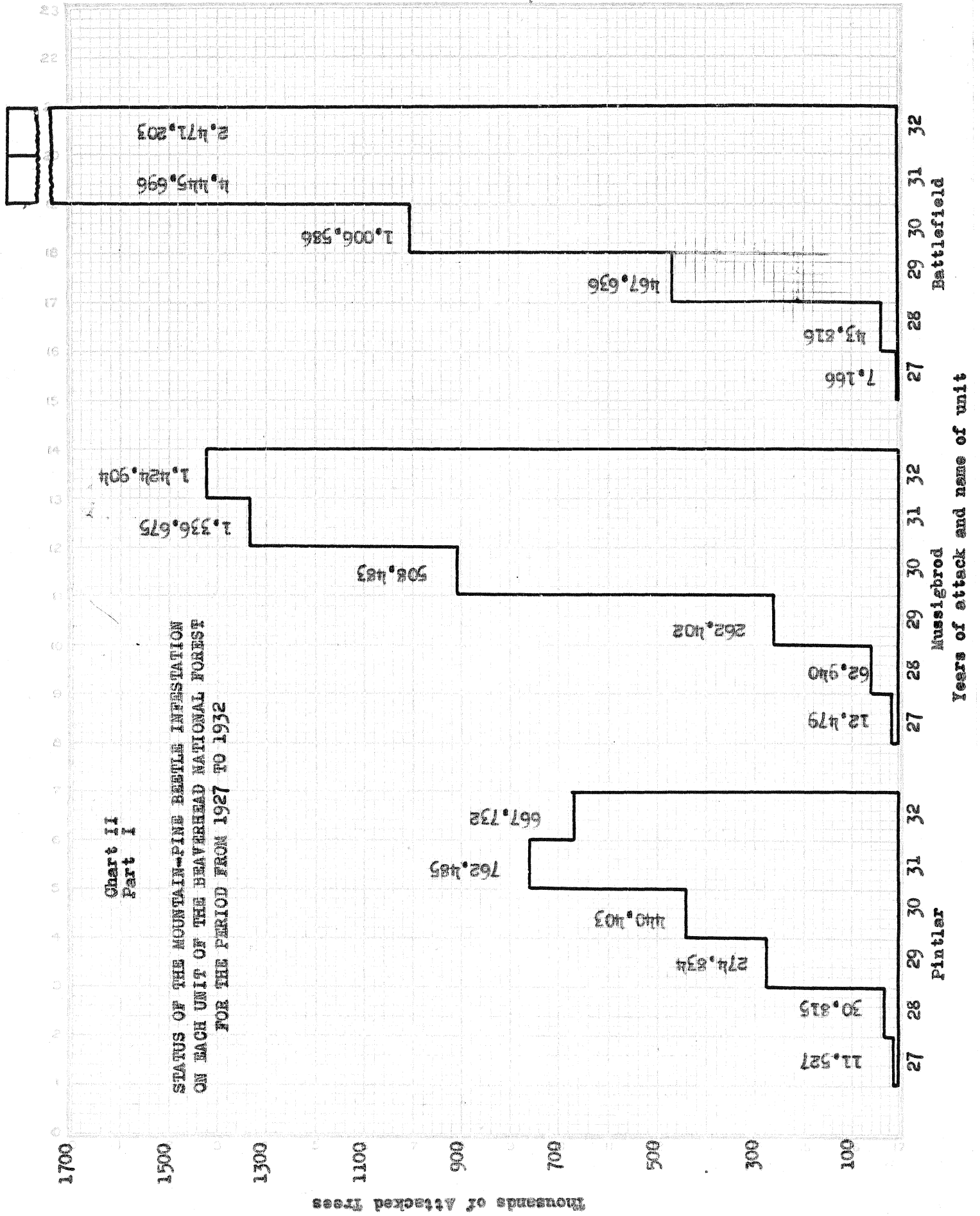


Chart II  
Part II

STATUS OF THE MOUNTAIN-PINE BEETLE INFESTATION  
ON EACH UNIT OF THE BEAVERHEAD NATIONAL FOREST  
FOR THE PERIOD FROM 1927 TO 1932



Thousands of attacked trees

Chart II  
Part II

STATUS OF THE MOUNTAIN-PINE BEETLE INFESTATION  
ON EACH UNIT OF THE BEAVERHEAD NATIONAL FOREST  
FOR THE PERIOD FROM 1927 TO 1932

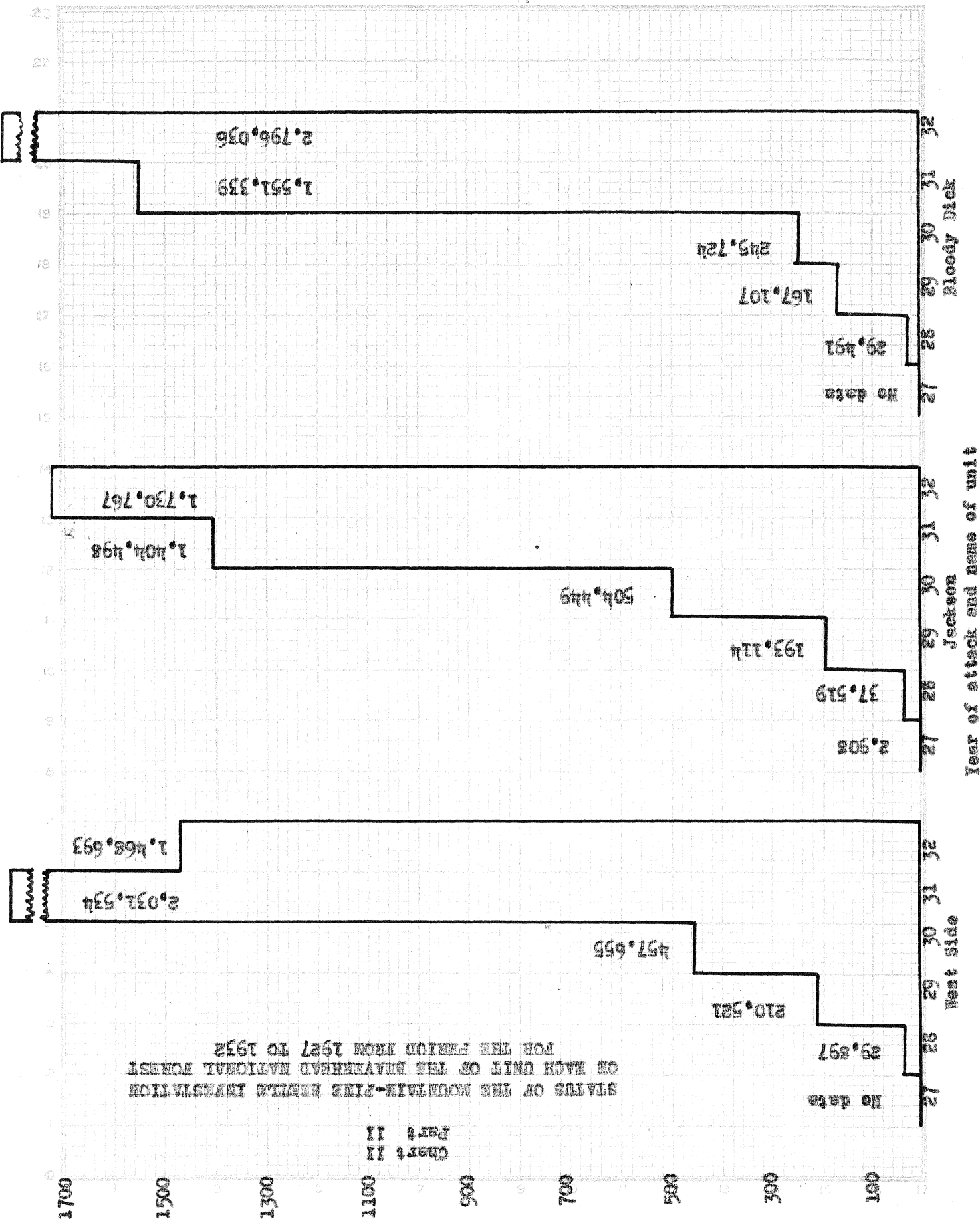
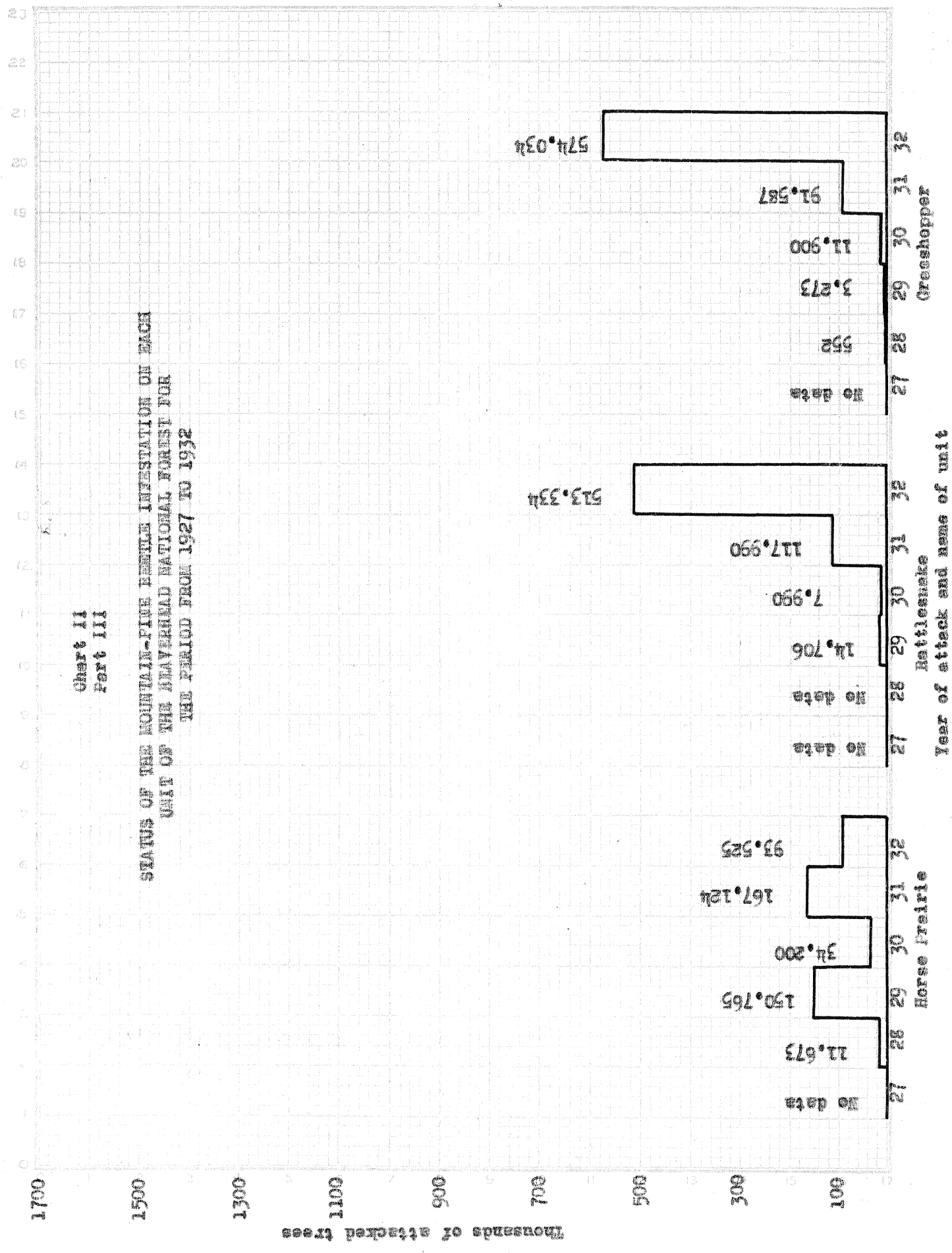
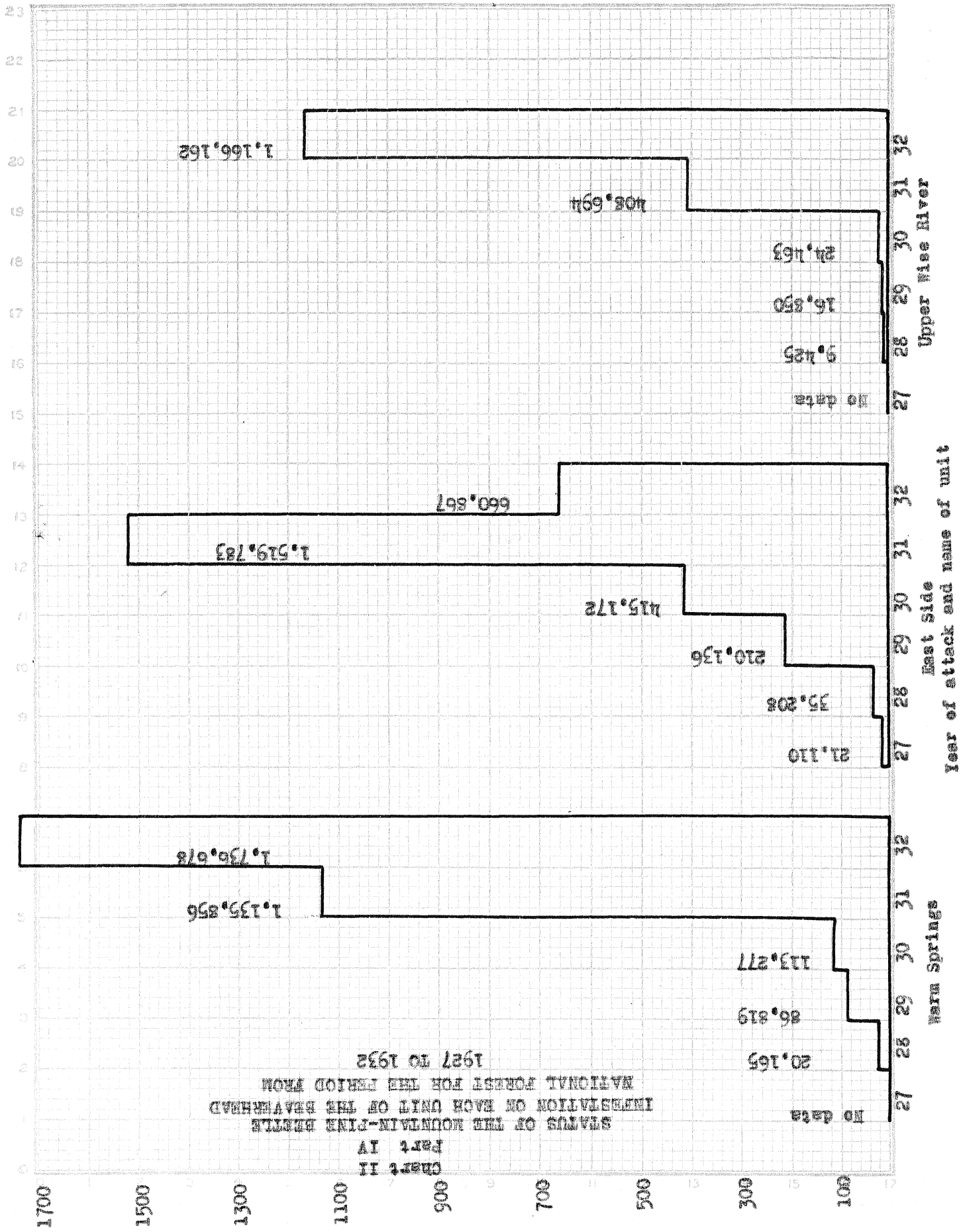


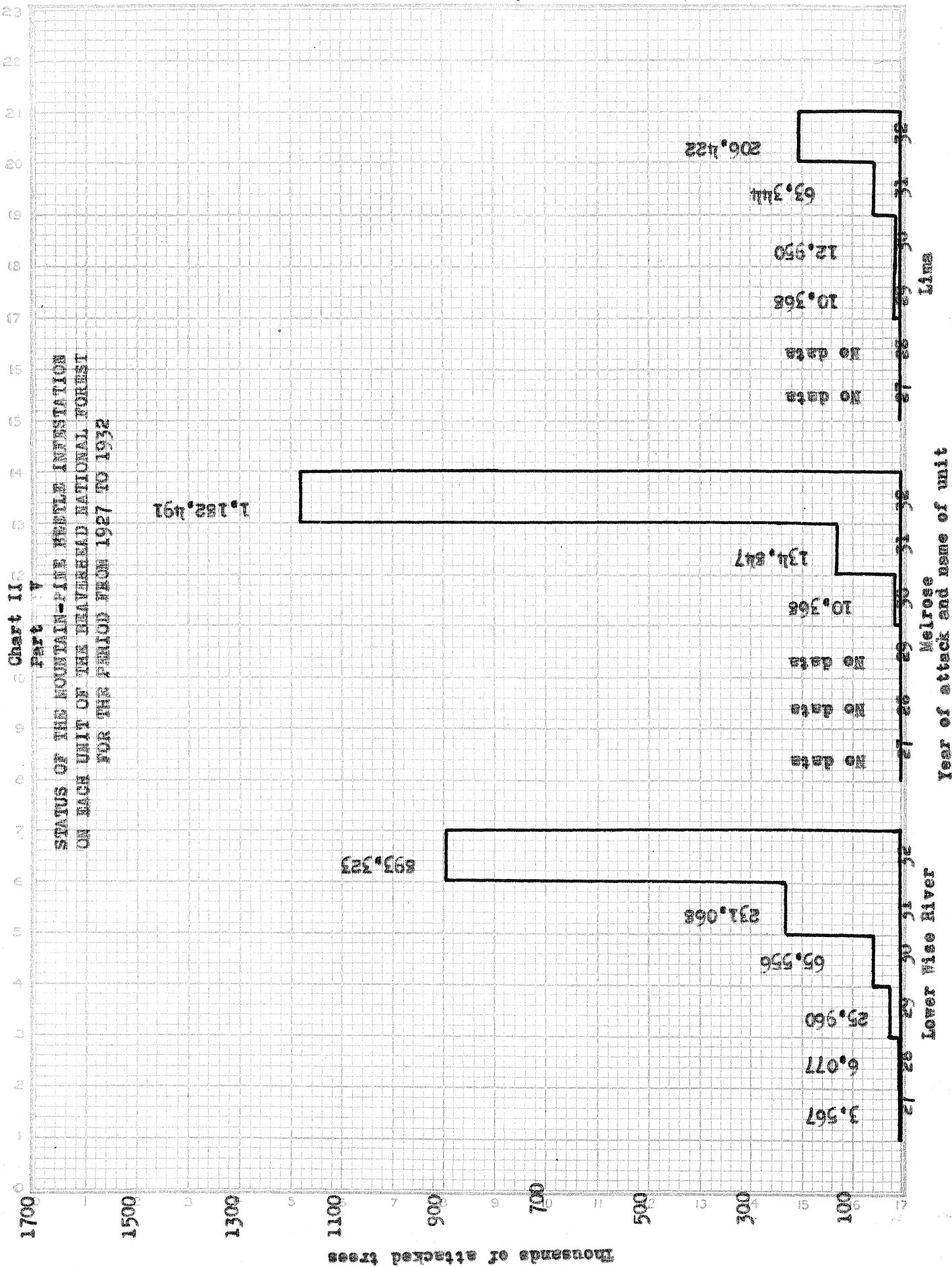
Chart II  
Part III

STATUS OF THE MOUNTAIN-PINE BEETLE INFESTATION ON EACH  
UNIT OF THE HAVERHARD NATIONAL FOREST FOR  
THE PERIOD FROM 1927 TO 1932









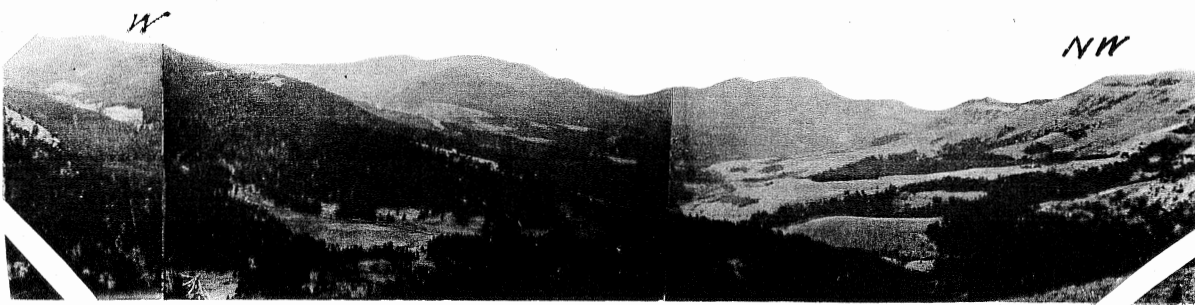
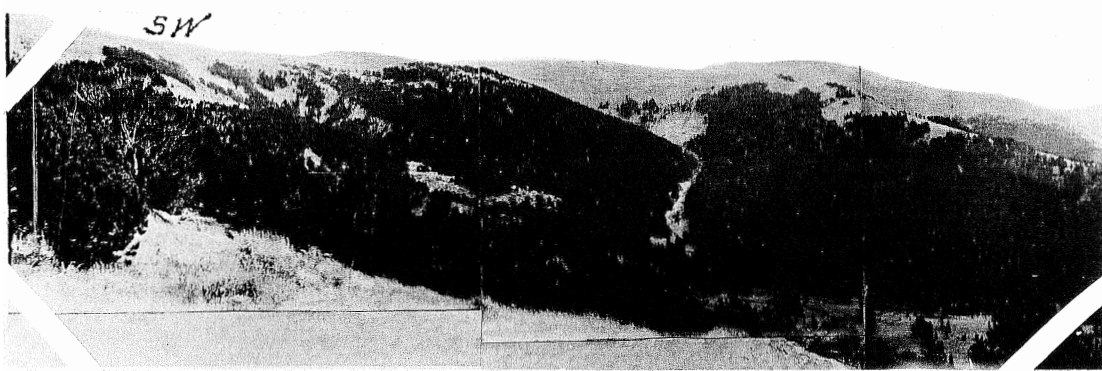


*Plate I*



Partial panorama from west side of Antone Peak showing head waters  
of west fork of Blacktail Creek - letters indicate direction.

*Plate II*



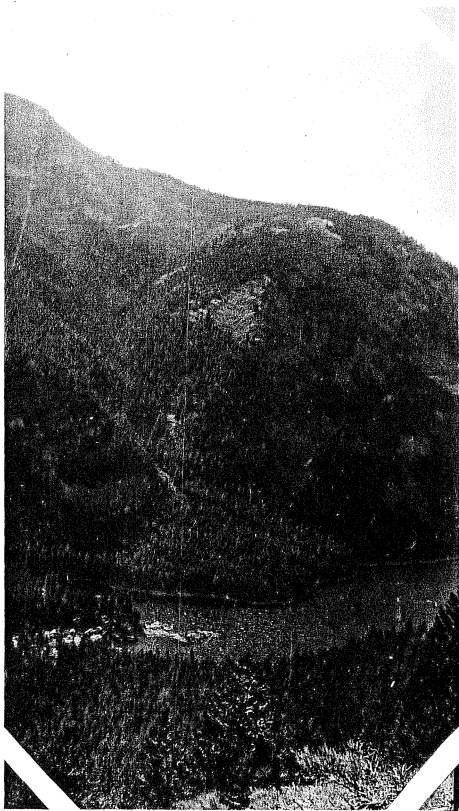
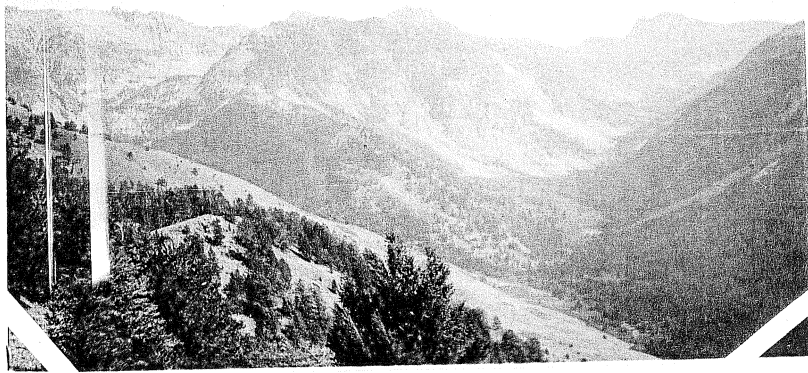
Partial panorama from eastern ridge of Snowcrest Range showing  
headwaters of East Fork of Blacktail Creek, Beaverhead National  
Forest - letters indicate direction.

Plate III



Partial panorama of Sheep Canyon Drainage in Blacktail Hills about 15 miles south of Dillon, Montana - Letters indicate directions.

*Plate IV*



Scenes on the Helrose and Lima  
Units of the Beaverhead National  
Forest showing some of the to-  
pography covered in the annual  
survey.